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Optical Tube-length and Magnification.

The last number of the JOURNAL of the Royal Microscopical Society contains an article by Mr. Frank Crisp the Secretary of the Society, which shows that the great majority of microscopists have held erroneous opinions concerning the relations of tube-length and the amplification of the optical combination in a microscope. The meaning of ten-inch tube has not been accurately defined, so far as we are aware, in any English text-book on the microscope. In practice some persons measure the tube itself, others say it should be the distance from the "optical centre" of the objective to the top of the tube, others again measure from the diaphragm of the ocular. The whole matter is in a state of utter confusion, and since the committee of the American Society of Microscopists has likewise been in the dark about the matter, as shown by the report in which the ten inches is measured "from the diaphragm of the ocular to the front lens of the objective," the article by Mr. Crisp comes in good time.

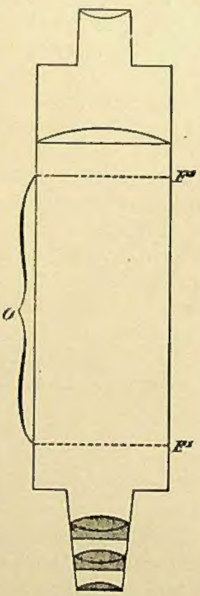

FIG 3.

For the complete consideration of this subject the reader is referred to the original article, but sufficient will be given in this place to make the subject clear.

It will be found in practice that:—"1. Two objectives of precisely the same focal length, used with the same tube and the same eye-piece, may nevertheless give different magnifying powers. 2. Two objectives of different focal lengths, used with the same tube and eye-piece, will not give magnifying powers in proportion to their focal lengths; thus a ½-inch will not necessarily give double the power of a 1-inch.

"Conversely, two eye-pieces will not amplify in proportion to their focal lengths, though used with the same tube and objective."

The true magnification may differ by 100 per cent. from the power calculated upon the ordinary assumptions. The explanation is found in the erroneous notions concerning tube-length.

The magnification of a lens is determined by its focal length. It is measured by dividing ten inches, the distance of distinct vision, by the focal length. Let f = focal length, l = 10 inches, M = magnifying power. Then $M = \frac{l}{f}$. For a ⅛-inch, M = $10 \div \frac{1}{8} = 80$ diameters. The magnifying power of an objective is immediately given by multiplying the denominator of the fraction expressing its focal length by 10. Thus a $\frac{1}{5}$ magnifies 50, a $\frac{1}{6}$, 60, if the image be received on a screen 10 inches from the posterior focal plane of the lens.

For microscopical use it is necessary to extend this formula to the com-

bination of objective and ocular. Heretofore it has been customary to calculate the power of the compound microscope by multiplying the power of the objective by that of the ocular, assuming the tube to be ten inches long. This rule is founded upon the supposition that the focal length of the combination of objective and ocular is the product of the focal lengths of objective and ocular divided by 10, or $f = \frac{f^1 \times f^2}{10}$, in which f^1 = the focal length of the objective and f^2 of the ocular.

This would be true if the optical tube-length were 10 inches, but in practice no distinction is made between the optical and the actual tube-length.

The meaning of optical tube-length must now be explained. In fig. 3 the dotted lines F^1 and F^2 represent the posterior focal plane of the objective and the principal focal plane of the ocular, respectively. The distance from F^1 to F^2 is the optical tube-length.

If this length be represented by *o* the true focus of the combination of objective and ocular will be not $f = \frac{f^1 \times f^2}{10}$, but $f = \frac{f^1 \times f^2}{o}$.

The importance of this distinction between actual and optical tube length will be readily appreciated when it is considered that with a $\frac{1}{8}$-inch objective the focal plane is close to the back lens, while with a lower power, such as a 1-inch for example, it is considerably removed from it.

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The Abbe Illuminator.

Mr. J. Grunow, of New-York, gives the following instructions for using this illuminator as constructed by him :—

The apparatus consists of a lens-system of very wide angular aperture, two revolving diaphragm-plates, in conjunction with the plane and concave mirrors on the stand proper. The upper plane side of the lens-system should be almost even with the upper surface of the stage, so that it almost comes in contact with the slide. For observation by central light, the diaphragm with central openings is used, viz., a narrower or wider diaphragm, according to the focal distance of the objective in use, the nature of the object-slide, and the intensity of the source of light. Generally, the narrowest diaphragm is to be recommended, as it gives sufficient light. Used without a diaphragm, the condenser invariably gives an unsatisfactory illumination.

By moving the diaphragm openings to the right or left, partly out of the optical axis, oblique illumination is obtained.

For dark field illumination the star-shaped diaphragms are used instead of the aperture for central illumination, and always used in the central position. At the same time it is, however, preferable to reduce the aperture of all the high-power objectives, say from one-fourth inch up, by placing a diaphragm in the back of the objective employed. The diaphragm is, however, to be taken out again in every case when the objective is used for transmitted light. Objects not transparent cannot be viewed by this illumination, as the working rays of light have to pass through.

The polariscope can be used in connection with this apparatus. For this purpose the condenser must have room enough underneath the stage to have an attachment for holding the polarizer. Polarized light can be used then for central as well as oblique illumination.

In using the condenser, the plane mirror is generally used. Only when viewing with very low powers, when the plane mirror does not completely illuminate the whole field of view, the concave mirror is used. In every instance where the mirror is once adjusted for full illumination, the changing of the diaphragms does not affect it.

When using lamp-light, it is recom-

mended to use as large a condensing lens as possible, or perhaps a large glass ball filled with water, in order to secure an evenly illuminated field of view without moving the flame too near the microscope. The condensing lens or the glass ball is placed in such a position between the lamp and the microscope that an image of the flame is projected on the plane mirror.

When, in using immersion lenses, very oblique illumination is desired, or when dark field illumination under high amplification is used, it is advantageous to place a drop of water on the upper surface of the condensing lens of the apparatus, so as to fill up the space between it and the under side of the object-slide with a medium denser than air.

The usefulness of this apparatus has been recognized by all who have became familiar with its use, and it is not only employed as an ordinary accessory, occasionally, but as a constant auxiliary in daily application.

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New Centering Turn-table.

The turn-table represented in Fig. 4 is the invention of Mr. Joseph Zentmayer, of Philadelphia, and it needs no words of ours in its favor when the maker is so well known, for nothing that is not mechanically excellent has ever come from Mr. Zentmayer's hands.

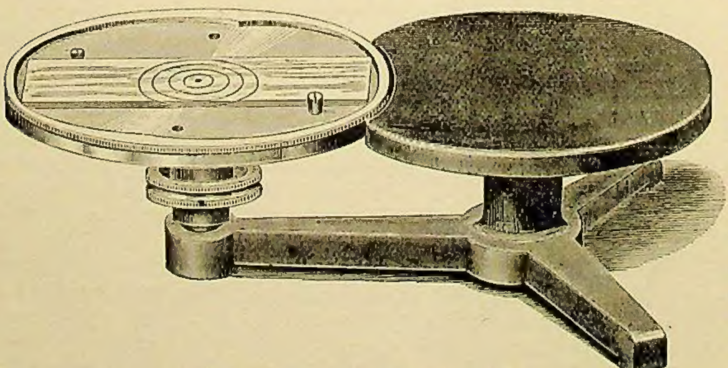

FIG. 4.—Zentmayer Centering Turn-table.

The plan of centering the slide is quite original and perfect in its results. The slide is placed so that its edges are in contact with the two pins projecting from the face of the plate. A ring with an oval inner edge is fitted to the periphery of the disk, in such a way that by turning it the slide is grasped at the diagonally opposite corners by the inner edge of the ring, and is thus centered longitudinally. The two pins centre it the other way.

The ring may be easily removed, and spring clips substituted when desirable.

The figure will afford a better idea of the device than can be given by words. The price of the turn-table is $5.00.

Next month we shall describe another of Mr. Zentmayer's improvements, which is a new form of detaching nose-piece, the number of which is rapidly increasing.

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Adulteration of Lard.

Dr. W. T. Belfield describes his method of detecting tallow in lard by the microscope in the *Proc. Am. Soc. Mic.* The process is as follows:—

Ten grains of the material to be examined are dissolved in two drachms of Squibb's ether, in an open test-tube. As the ether evaporates, crystals are deposited. These may be examined in the etherial solution, but it is better to pour off the mother liquor and wash the crystals once or twice with clean ether. By thus examining the crystals under the microscope pure lard will show thin, rhomboidal plates, the obtuse angles of

which measure about 105 degrees. Pure tallow appears in long curved crystals, single or in groups. The crystals should be obtained by evaporation in the tube without heat, not by evaporation on the slide. Ten per cent. of tallow in lard can thus be detected, and probably five per cent. The addition of 15 per cent. of lard to tallow was also detected by this method by Dr. Lester Curtis, without experience with the method. It is probable that an experienced observer could detect a still smaller proportion with certainty.

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A New Infusorian Belonging to the Genus Pyxicola.

BY DR. ALFRED C. STOKES.

The loricate infusorium represented in fig. 5, magnified 450 diameters, appears to be undescribed; but on account of the difficulty a student has of keeping even partially informed of the progress of investigation among the lower forms of animal life, the writer names it *Pyxicola constricta* provisionally. As the animalcule is probably not uncommon, although I have thus far found it in but one locality, it may easily have been described in the recent past and the publication have failed to come to my notice.

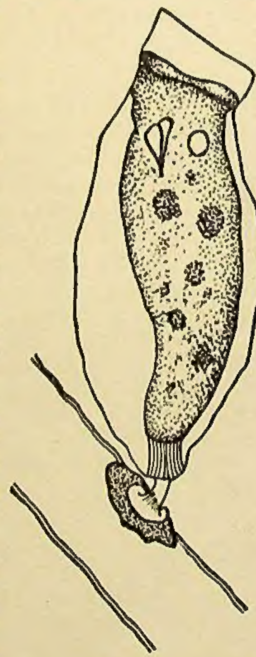

FIG. 5.—Pyxicola constricta, n. sp. X 450.

The urceolate lorica, slightly curved and gibbously inflated, is widest centrally, whence it gradually diminishes in diameter anteriorly, to the origin of the produced, truncate, obliquely set neck, immediately behind which it is somewhat constricted, and posteriorly to the truncate area of insertion of the short pedicel, above which, at a distance almost equalling the pedicel in height, it is again constricted thus forming a distinct posterior prolongation; the outline of the lorica, as seen in optical section, is more or less irregularly undulate; height about two and one-fourth times the width; it varies with age, as usual, from colorless and hyaline to a semi-opaque chestnut-brown.

Pedicel one-twelfth the height of the lorica, finely striate or wrinkled lengthwise, permanently transparent, but at the point of attachment to the water-weed surrounded by a broad, irregularly outlined annulus, which varies in color with the lorica and is often found adherent to the plant after the entire infusorium has disappeared.

Enclosed animal colorless; when expanded subcylindrical, slightly tapering posteriorly and attached to the lorica through the intermedium of a short, thick, longitudinally and finely striate foot-stalk; when fully extended, about one-fifth of its entire length protrudes beyond the aperture; otherwise it does not apparently differ from the other animals of the genus.

The operculum is conspicuous in the older individuals only, and when retracted completely occludes the orifice at the point of constriction of that part of the lorica which is obliquely produced to form the neck. It is disk-shaped and changes in color with the lorica.

The systole of the pulsating vesicle takes place once in thirty seconds.

Height of the lorica $\frac{1}{315}$-inch.

One method of reproduction is by the formation of a lateral bud and its subsequent separation as a ciliated germ, whose complete development I have not been able to follow.

This species of pyxicola I have taken attached in some profusion to an alga growing in the Delaware and Raritan Canal, and from that locality only.

TRENTON, N. J.

Has Salpingœca Urceolata, S. K., a Fresh-Water Habitat?

BY DR. ALFRED C. STOKES.

In this JOURNAL for November last the writer expressed the supposition that *Salpingœca urceolata*, S. K., is not more restricted to salt-water than is a certain almost cosmopolitan infusorian frequently met with by every

FIG. 6.—Salpingœca urceolata.

FIG. 7.—Salpingœca acuminata, deformed.

observer. The statement was based upon a somewhat limited experience of early spring. At the time, I could not speak with absolute certainty, as this salpingœca seems rather rare, and as I had not captured it again until the article above referred to was in print. Since then, however, I have taken the same creature on *Myriophyllum* from another locality, and, upon comparing this recent find with the description and figures of Kent's typical marine form, the differences appear so slight and the resemblances so many and strong, that an observer must be convinced that it is either *Salpingœca urceolata* with a fresh-water habitat, or at least a fresh-water variety. The resemblance holds true even in that peculiar and characteristic contractility of the lorica-neck in the marine form.

The lorica of the salpingœca found by the writer is represented in fig. 6 reduced from a pantographic enlargement of a camera drawing. After the animal had been on the slide for some time, the zooid retracted the collar and flagellum, and withdrew itself entirely out of the neck into the body of the lorica; it was in that condition, and was purposely omitted, when the drawing was made to show the similarity of the contracted lorica-neck to the same part in Kent's figure. Differences which I have noticed between the fresh-water and marine forms are the somewhat smaller size of the lorica and the slightly increased length of the pedicel of the former, differences of the very least importance.

May I here also ask the reader's attention to fig. 7 as an interesting deformity? The salpingœca there shown is apparently the species described by the writer in this JOURNAL under the name of *S. acuminata*. How the animal happened to properly form one side of its lorica and to get the other so out of sorts is a mystery. It is easily imagined, however, that after producing the pedicel and the posterior fourth of the sheath, the salpingœca was, by some overwhelming force, thrown against an uneven sur-

face from which the young foot-stalk was at that stage not sufficiently elastic to lift it, while the zooid was compelled by some innate influence to continue the secretion of the lorica, so that one side took the shape of its irregular support.

TRENTON, N. J.

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Swift's Fine-Adjustment.

A form of fine-adjustment was introduced by Mr. Swift, of London, some time ago, which we understand is not expensive to make, while it is certainly very effective and smooth in action. If the reader will turn to fig. 45, on page 229 of the preceding volume of this JOURNAL, a cut of a stand with this adjustment will be found. It will be seen that the milled head for fine focussing is placed on the side of the limb, a position which is in some respects advantageous.

The mechanism of the slow motion is shown in fig. 8. By turning the

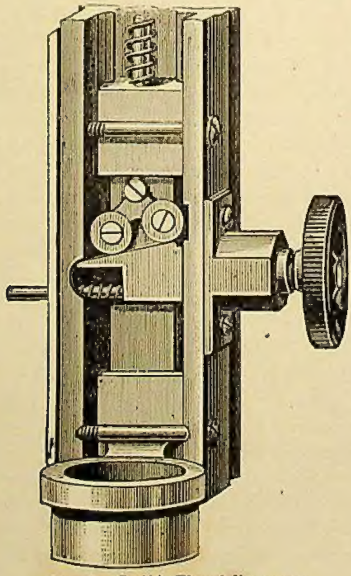

FIG. 8.—Swift's Fine-Adjustment.

milled head the wedge-shaped piece is moved laterally, and thus imparts an up or down motion to the parts bearing on the two rollers.

The same adjustment is applied to the stand figured in fig. 9, which is also made by Messrs. Swift & Son,

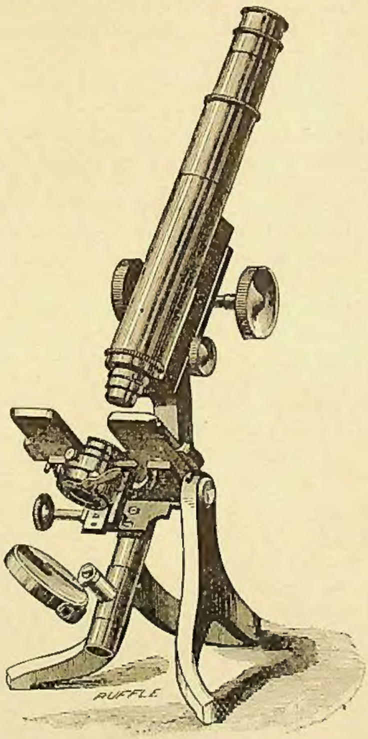

FIG. 9.—Swift's Microscope.

embodying certain features recommended by Mr. E. M. Nelson.

In this stand the stage is cut away in front, so as to afford a view of the substage apparatus, and thus facilitate the use of accessories beneath the stage.

The stand is a very simple and good one. It has a centering substage, with a rack, and diaphragms are attached so as to be readily swung aside and removed from the carrier. The body-tube divides, to make the stand more portable. We have seen this stand used with high-power objectives, for which it is perfectly well adapted.

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Measuring Blood-Corpuscles.

In the December number of this journal was printed an excellent article by that careful and skilful observer,